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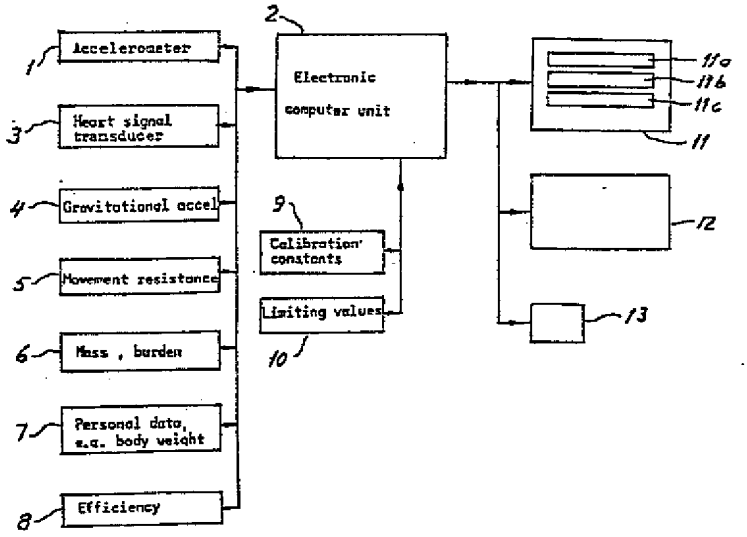
(57) Abstract

An Ergometer, preferably personally carried and includes an accelerometer (1). The accelerometer (1) is very sensitive and is adapted for giving a continuous signal corresponding to the momentary acceleration. The ergometer further includes electronic means (2) for calculating momentarily developed force, power and/or energy on the basis of the acceleration signal. The ergometer in one embodiment has a display or indication means (11), e.g. adapted in digital or analogue form to show values for momentary force (11a), momentary force (11a), momentary power (11b) and/or developed work (11c) or energy corresponding thereto and expended by a person. In another embodiment, the ergometer has memory or registration means (12) adapted for storing values at different times for momentary force (11a), momentary power (11b) and/or developed power (11c) or energy corresponding thereto, rendered by a person. It can have means which transmit a signal when a predetermined value of the momentary power and/or the developed work has been attained. The ergometer can finally also have a) a means (3) for measuring and/or registering the number of heartbeats and b) a means for calculating the value of force, power and/or developed work in relation to heart activity.



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Ergometer

The present invention relates to an electronic performance-measuring device, e.g. a personally carried ergometer which measures the physical work or the physical stress a person is subjected to. Such an ergometer can be used for measuring the physical activity during daily activity as well as during intensive physical activities, e.g. in connection with participation in sports.

Personally carried performance meters are already known. For example, the Swedish published specification - Patent application 7807902-7 describes an apparatus in which a person's movements affect a magnetic device, which gives a measurement of the acceleration, and thereby also the force the person exercises. The described device is, however, quite unsatisfactory, since the accelerometer used, which is based on a magnet movable in a magnetic field, only gives a signal above a certain threshold value and thus lacks ability to provide continuous signals corresponding to the acceleration. Work executed with accelerations under the threshold value gives a continuous signal, which incorrectly indicates that no work is being done, while movements with an acceleration greater than the threshold value are registered as work executed at the lower acceleration represented by the threshold value. It is thus quite obvious that a device of the kind described cannot achieve a correct measurement of the physical work performed by the person carrying it.

According to the invention, the described disadvantages are circumvented and a number of advantages obtained. With the invention, the momentary value of the acceleration is sensed continually and a time integral formed to attain the speed and also a further time integral for obtaining the magnitude of the displacement. By multiplication with a suitable factor, there is correspondingly obtained

information as to the momentary values of force and power and the value for work performed during a given period of time.

In the case where a personally carried ergometer is carried in a vertical position, e.g. in a breast pocket, the vertical acceleration is measured. The mentioned factor can then include information as to age, weight, length, sex or other personal data which, in a mode already known, constitute parameters for physical performance. When a person moves upwards and downwards, e.g. on staires or on a slope, work is also done during the movement downwards. The mentioned factor can then also contain an increment for this development of energy, put in relation to the values for movement upwards in the case where only upward movement is measured. Other factors can also be incorporated in this factor, e.g. the efficiency of a certain kind of work.

More particularly, the disadvantages discussed are avoided, and the above-mentioned advantages obtained by the ergometer in accordance with the invention containing an accelerometer which is adapted for giving a continuous signal corresponding to the momentary acceleration, and that the ergometer includes means for calculating force, power and/or energy.

Of the different embodiments envisaged in one embodiment, the ergometer contains a multiplier, adapted to multiply the acceleration signal with a factor for the purpose of obtaining a measurement of the force causing the acceleration.

In a second embodiment, the ergometer also includes means for integrating the acceleration signal with respect to time for the purpose of obtaining a signal for the momentary velocity and development of power.

In a third embodiment the ergometer in accordance with the invention includes means for integrating the signal for the momentarily developed power for a given period of time for the purpose of obtaining a value for the work developed during the period.

The ergometer can further include an indication means, arranged in a digital or analogue form for showing the values for force, momentary power and/or developed work and the amount of corresponding energy expended by a person.

In a fourth embodiment the ergometer includes memory or registering means adapted for storing values for force, momentary power and/or developed work at different times during a defined period of time.

In a fifth embodiment, which can be of immediate interest in executing physical performances, the ergometer includes means arranged to give a signal in response to a definite value of the momentary power or effort and/or work developed.

Since work is also performed during walking or running on flat ground, the ergometer in one embodiment includes means for measuring the acceleration in at least two directions, there are also being means adapted for calculating force, power and/or work developed in said directions. The developed work inputs measured in the different directions can be combined into a value for total work performed.

Apart from means for measuring, indicating and/or registering the values of performed physical work, the ergometer also includes, in a seventh embodiment, a means for measuring and/or registering the number of heartbeats. In this way, values of force, power and/or developed work in relation to heart activity can be obtained, which gives in-

teresting information concerning the heart response to the work performed during a day's work, for example, or during some executed physical performance. After the activity of a working day, which as a rule includes other stress factors than the purely physical ones, it is possible in this way to also obtain a measurement of the psychical stress, for example, during which the heart beats quicker than what is required by the physical work. A pocket ergometer in this embodiment opens the way for obtaining a quantitative measurement of different types of stress.

Since large demands are placed on the sensitivity of the accelerometer, this comprises, in accordance with the invention, a polarized ceramic spring, one end of which is rigidly fixed. For obtaining further increased sensitivity, the spring can be provided with a mass, e.g. of lead, at its free end.

The signal from the ceramic spring is taken out via two terminals, one on either side of the spring at its place of fixation.

The invention will now be described below in detail while referring to the appended drawing.

On the drawing there is a block diagram of the ergometer and its different components. The accelerometer for measuring the movement acceleration is denoted by the numeral 1. The signal corresponding to the acceleration is taken to component 2 which is an electronic calculating unit for processing all the data with which the ergometer operates. The electronic computer 2 is also supplied with the signal from a transducer 3 for giving heart-pulse signals. From a plurality of components, denoted by the numerals 4-9, there are fed in values for gravitational force/acceleration, movement resistance, mass or burden,

personal information such as body weight, efficiency and calibrating constants. The computor is fed limiting values from a component 10 for different values, e.g. signal values, e.g. signal values of momentary power and work executed.

From the electronic computer 2 output signals are taken to a display 11, which can have three different indication areas, such as 11a for force, 11b for momentary power development and 11c for work performed. A memory unit can be connected to the computer output, said unit storing the calculated measured values possibly presented in the display 11, or other values at given times or during a given period of time. The computer is finally connected to an acoustical or optical signal transmitter 13, coming into function when set limiting values from the unit 10 are attained.

The signal from the accelerometer 1 can be multiplied in the computer 2 by a factor which is dependent, for example, on values obtained from the component 6 for mass and component 9 for calibration constants, whereby the force which causes the acceleration can be calculated and whown on the display 11.

By processing in the computer, with the aid of the accelerometer signal from the component 1 together with information as to body weight, mass, and efficientcy, the work performed and the energy expended can be calculated. One or both of these values can be shown in the areas on the display 11.

In the special case where movement takes place vertically, as in motion up or down steps or staircases, it is suitable that only the upward velocity is integrated to obtain performed work, while the downward velocity is neglected. The computor can then show the sum of the upward movements expressed in meters of "effective height rise", for example,

By processing this value in the computor, there is also obtained a measurement of the quantity of work performed in joules or calories.

The arrangement just described is very suitable for measurements in conjunction with the wellknown "step-test", where the subject steps up and down on a single step. In this test, as with other measurements, a personally carried ergometer should be attached or carried close to the centre of gravity of the person in question.

Although only cases have been dealt with in the examples given where the acceleration is measured for substantially linear movement in one or more directions, it is also possible to use the invention for rotating movements, e.g. for ergometric bicycles, where the rotational acceleration is measured, e.g. by accelerometers directed radially outwardly from the rotational axis. Other arrangements are also conceivable within the scope of the patent claims.

Claims:

1. An ergometer, e.g. a personally carried ergometer, including an accelerometer (1), characterized in that the accelerometer (1) is adapted to give a continuous signal corresponding to the momentary acceleration, said signal being taken to means (2) adapted for calculating force, power and/or energy.

2. Ergometer as claimed in claim 1, characterized in that it further includes a multiplier (2) adapted for multiplying the acceleration signal with a factor for the purpose of obtaining a measurement of the force (11a) causing the acceleration.

3. Ergometer as claimed in claim 2, characterized in that it comprises means (2) for integrating the acceleration signal with respect to time for the purpose of obtaining a signal (11b) for the momentary power.

4. Ergometer as claimed in claim 3, characterized in that it includes a means (2) for integrating the signal for the momentarily developed power during a given period of time, with the object of obtaining a value of the work (11c) developed during the period.

5. Ergometer as claimed in one or more of claims 1-4, characterized in that it includes a display or indicating means (11), e.g. adapted for showing in digital or analogue form values for force (11a), momentary power (11b) and/or developed work (11c) or energy corresponding thereto expended by a person.

6. Ergometer as claimed in any of claims 1-4, characterized in that it includes memory or registration means (12), adapted for storing values at different times for force (11a), momentary power (11b) and/or developed work (11c) or energy corresponding thereto expended by a person.

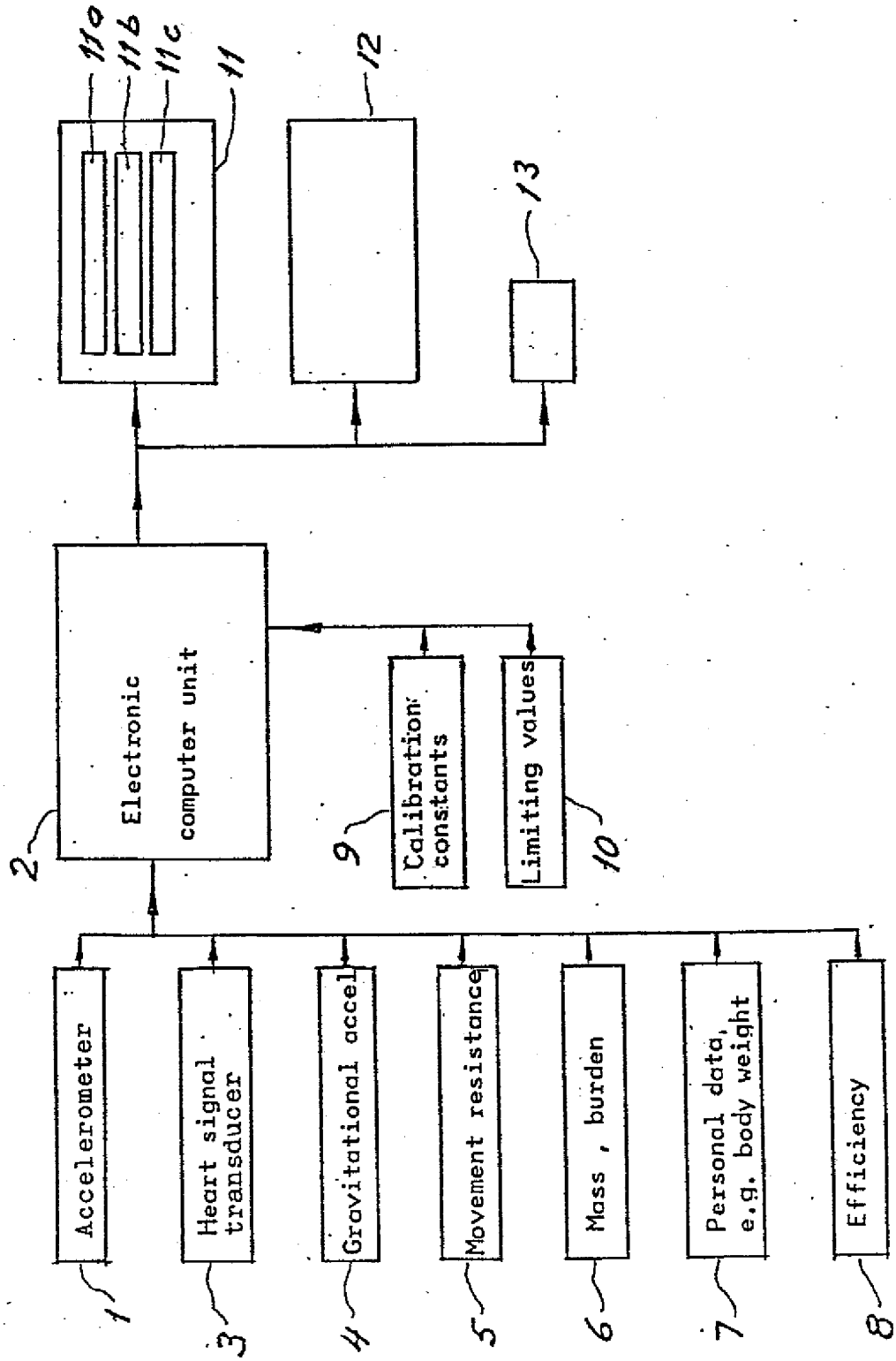
7. Ergometer as claimed in any of claims 1-4, characterized in that it includes means adapted to transmit a signal in response to the value of the momentary power and/or developed work.

8. Ergometer as claimed in any of the preceding claims, characterized by means (1) for measuring acceleration in at least two directions, there also being means (2) adapted for calculating force, power and/or developed work in said directions and the total value thereof.

9. Ergometer as claimed in any of the preceding claims, characterized in that it further includes a) an apparatus (3) for measuring and/or registering the number of heartbeats and b) a device for calculating the value of force, power and/or developed work in relation to heart activity.

10. Ergometer as claimed in claim 1, characterized in that the accelerometer includes a polarized ceramic spring, one end of which is rigidly fixed, the signal from the spring being taken out via two terminals, one on either side of the spring at its fixed position.

11. Ergometer as claimed in claim 10, characterized in that the ceramic spring is provided with a mass, e.g. lead at its free end.



SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE80/00318

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

A 61 B 5/10; A 63 B 21/00; G 01 P 15/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	A 61 B 5/00, /10; A 63 B 21/00; G 01 P 15/00, /08
US Cl	73:379-381, 503, 506, 517-518; 128:2.05 R, 2.06; 272:73; 310:8, 9.4

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 2 837 082 published 1958, June 3, R.V. Elliott et al. column 1, lines 19-21 and 69-72, " 2, " 3-7 and 10-13, " 3, " 66-67	1,5
A	US, A, 3 233 466 published 1966, February 8, The Bendix Corp.	10,11
A	US, A, 3 284 708 published 1966, November 8, Systron-Donner Corp.	3,4,6

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"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [3]	Date of Mailing of this International Search Report [3]
1981-01-22	1981 -01- 26

International Searching Authority [1]	Signature of Authorized Officer [20]
Swedish Patent Office	Gunnar Hilderot